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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/608,639
Filing Date: June 30, 2003
Appellant(s): KANG ET AL.

Kenneth D. Springer
For Appellant(s)

EXAMINER'S ANSWER

This is in response to the Supplemental Appeal Brief filed on January 8, 2007 appealing from the final Office action mailed on November 18, 2005.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The Examiner is not aware of any related appeals, interferences, or judicial proceedings that will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

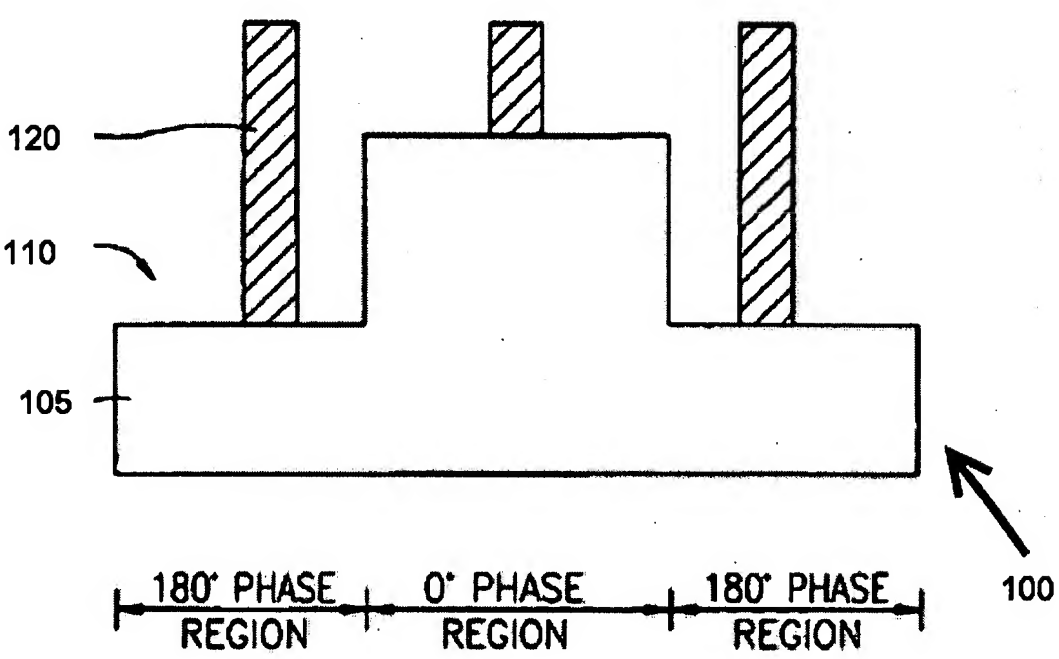
The Appellant's statement of the status of amendments after final rejection contained in the brief is essentially correct, with the exception of *when* the 2/14/06 after final amendment was actually entered. Appellant states on page 2 of the brief that this after final amendment was entered "*upon* the filing of this Appeal" (emphasis added). However, this after final amendment was actually entered as indicated in the 3/7/06 Advisory Action, *before* the 4/18/06 notice of appeal.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct. However, it is noted that only claims 7, 14, and 16 are independent, whereas all of the other claims summarized in this section are dependent claims. Also, Appellant's description of the claimed subject matter in terms of directional orientations (e.g., "situated beneath", "bottom surface" (both in reference to claim 7) and "bottom of the trench" (in reference to claims 14 and 16), etc.) are inverted from the way the corresponding instant Figures 3A and 5A-5C are actually presented (as last amended

on 8/29/05). Therefore, for the convenience of the Board, the 8/29/05 version of instant Figure 3A is reproduced in inverted form, as shown below.

Instant Figure 3A (inverted)



(6) Grounds of Rejection to be Reviewed on Appeal

The Appellant's statement of the grounds of rejection to be reviewed on appeal is substantially correct in summary form. The changes made are as follows: (a) the rejection of claims 2-12 and 14-20 under the second paragraph of 35 U.S.C. 112 (listed as "(1)" on page 5 of the brief) is now withdrawn, in order to reduce the issues for appeal.

WITHDRAWN REJECTIONS

The following grounds of rejection are not presented for review on appeal, because they have been withdrawn by the examiner. The rejection of claims 2-12 and 14-20 under the second

paragraph of 35 USC 112 (listed as "(1)" on page 5 of the brief) has been withdrawn (as indicated above).

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,567,552	Ham	10-1996
6,737,198	Kamon	5-2004
2002/0094492	Randall et al.	7-2002
2002/0031711	Steinberg et al.	3-2002

(9) Grounds of Rejection

The first rejection listed as "(1)" on page 5 of the brief has been withdrawn, as indicated above.

The text of those sections of Title 35, U.S. Code not included here can be found in a prior Office action.

The following ground(s) of rejection are applicable to the appealed claims:

A. Claims 2-5, 7-10, 12, and 14-15 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Ham (US Patent 5,567,552).

Ham teaches a (phase edge) phase shift mask (PEPSM, claims 3-4, Figure 2, and column 2 lines 60-63) and a method of fabricating such a PEPSM (abstract, Figures 1A-1F, and column 2 lines 13-59). As shown in Figure 2, the PEPSM 10 has a transparent quartz substrate 1 in which is etched grooves or trenches 3 of width B constituting 180° phase shift regions separated by an unetched transparent 0° region of width A, wherein each trench 3 has a sidewall surface

3A and a bottom surface extending therefrom. An opaque chrome (Cr) auxiliary pattern 5B is formed at the center of each trench bottom surface by coating Cr and etching back to leave only the desired portion of Cr. When this PEPSM is used to pattern a photoresist layer, it is considered to be inherently capable and fully suitable for forming a photoresist pattern at an area corresponding to an edge of each trench while not forming a photoresist pattern at areas corresponding to the Cr opaque auxiliary pattern (which specifically reads on the PEPSM and corresponding method of fabrication recited by *instant claims 2, 4-5, 7, 9-10, 12, and 14-15*; and further encompasses the PEPSM and corresponding method of fabrication recited by *instant claims 3 and 8* for an auxiliary pattern of optical interference material that is opaque).

B. Claims 6 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of Randall et al. (US Patent Application Publication 2002/0094492).

While teaching the other aspects of claims 6 and 11, Ham does not specify the line width of the opaque Cr auxiliary pattern to be 30-200 nm.

However, Cr line widths on a PSM in the instant range of 30-200 nm are well known. For example, Randall et al. teach a method of double exposure and a PSM therefore having orthogonal overlapping Cr regions 34 and 36 with critical line widths w_{34} and w_{36}, respectively, of 0.2 μ (200 nm, paragraph [0058] lines 4-6). Alternatively, a well-known "1X" mask having the same dimensions as those imaged on the resist for making a 0.16 μ (160 nm) wide gate electrode having a critical width includes a Cr opaque line width of 160 nm ([0004] lines 15-20, [0019] lines 7-11, [0038] lines 5-10, 22-26, and [0055] lines 18-22). Furthermore, gate electrode line widths on the order of 0.15 μ (150 nm) are also contemplated ([0012] lines 24-27) for a

corresponding PSM having a Cr opaque line width of 150 nm (*instant claims 6 and 11*). It is desirable to fabricate integrated circuit device features that are as small and closely packed as possible to provide a high level of functionality and performance for the circuit, due to small feature sizes [0002].

It would have been obvious to one of ordinary skill in the art at the time of the invention for the PEPSM and the corresponding method of fabrication taught by Ham to have employed an opaque Cr auxiliary pattern having a well-known line width of 150-200 nm (reading on the instant line width of 30-200 nm), so that the PEPSM would have features that are as small and closely packed as possible to provide a high level of functionality and performance, as taught by Randall et al., for a product (e.g., circuit device, etc.) made by patterned exposure through this PEPSM.

C. Claims 16-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of either Kamon (US Patent 6,737,198) or Steinberg et al. (US Patent Application Publication 2002/0031711).

Ham does not specifically teach an additional opaque or optical interference Cr auxiliary pattern formed at the center of the unetched transparent 0° region of width A.

Kamon teaches alternative embodiments of a PSM having etched recessed phase shifters (PS) and relatively narrow light shading, opaque, or optical interference auxiliary patterns 111 centered either at the bottom of the etched PS recesses in the substrate 10 (Figure 21G, column 17 line 49 to column 18 line 16) or on top of raised portions of the substrate 10 (Figure 22E, column 18 lines 17-36).

Steinberg et al. teach an alternative embodiment of a multi-level PSM in Figure 9(e) having raised transparent mesas or pedestals 902 on a transparent substrate 905 and patterned opaque metal (e.g., Cr, etc.) regions 906 on both the raised 902 and recessed 905 areas of the substrate (paragraphs [0047, 0081]).

It would have been obvious to one of ordinary skill in the art at the time of the invention for the PEPSM taught by Ham to have employed an additional opaque or optical interference Cr auxiliary pattern formed at the center of the unetched transparent 0° region of width A as taught by either Kamon or Steinberg et al. This would be for the same reason such an opaque or optical interference Cr auxiliary pattern was used at the center of each trench bottom surface (as taught by Ham) so that when this combined PEPSM (taught by Ham and either Kamon or Steinberg et al.) is used to pattern a photoresist layer, it would be inherently capable and fully suitable for forming a photoresist pattern at an area corresponding to an edge of each trench while not forming a photoresist pattern at areas corresponding to the Cr opaque auxiliary pattern or additional Cr opaque auxiliary pattern (which reads on the PEPSM recited by *instant claims 16 and 18-19* and further encompasses the PEPSM recited by *instant claim 17* for an auxiliary pattern of optical interference material that is opaque).

D. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of either Kamon (US Patent 6,737,198) or Steinberg et al. (US Patent Application Publication 2002/0031711), and further in view of Randall et al. (US Patent Application Publication 2002/0094492).

While teaching the other aspects of *claim 20*, Ham and either Kamon or Steinberg et al. do not specify the line width of the opaque Cr auxiliary pattern to be 30-200 nm.

The teachings of Randall et al. are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention for the PEPSM taught by Ham and either Kamon or Steinberg et al. to have employed an opaque Cr auxiliary pattern having a well-known line width of 150-200 nm (reading on the instant line width of 30-200 nm), so that the PEPSM would have features that are as small and closely packed as possible to provide a high level of functionality and performance (as taught by Randall et al.) for a product (e.g., circuit device, etc.) made by patterned exposure of a photoresist through this PEPSM for forming a photoresist pattern at an area corresponding to an edge of each trench while not forming a photoresist pattern at areas corresponding to the Cr opaque auxiliary pattern.

(10) Response to Argument

Response to the arguments under subheading "1)" on pages 5-8 of the brief:

The rejection of claims 2-12 and 14-20 under the second paragraph of 35 USC 112 has been withdrawn, as indicated above. Therefore, the arguments in the brief pertaining to this ground of rejection are moot.

A. Claims 2-5, 7-10, 12, and 14-15 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Ham (US Patent 5,567,552).

Response to the arguments under subheading "2)" on pages 8-11 of the brief:

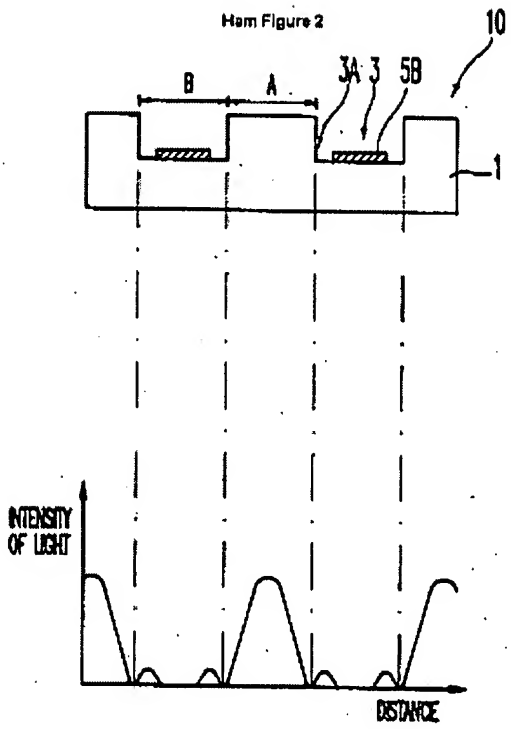
On page 8 of the brief, in lines 1-4 of the third paragraph under subheading "2)", Appellants argue that independent claims 7 and 14 include a combination of features "wherein, when the mask is used to pattern a photoresist layer, photoresist patterns are formed at areas corresponding to edges of the trench, and are not formed at areas corresponding to the auxiliary

pattern". It is noted that this language argued by Appellants differs from the actual language of appealed claims 7 and 14 (as represented in the claims appendix of the brief on pages 14-16). This language in claims 7 and 14 is better represented by --wherein[[,]] when the mask is used to pattern a photoresist layer, a photoresist ~~patterns are~~ pattern is formed at ~~areas~~ an area corresponding to ~~edges~~ an edge of the trench, and ~~are~~ is not formed at areas corresponding to the auxiliary pattern-- (in which the markings are added to show the differences in the language of the appealed independent claims 7 and 14 from the corresponding language argued by Appellants).

On page 9, Appellants invite the Board to compare instant Figures 3A-3B with Figure 2 of Ham. It is conceded that the intensity of light curve illustrated by instant Figure 3B is different from that illustrated by Ham's Figure 2. However, it is not instant Figure 3B that stands rejected over Ham, but rather the actual recitations of the instant claims that remain rejected over Ham. In the phase edge phase shift mask (PEPSM) of instant claim 14 and the method of fabricating the PEPSM of instant claim 7, the actual mask structure and materials, as well as the method of making this PEPSM, are both met by Ham (as described throughout prosecution and again set forth above). In fact, Appellants have not disputed the similarity of Ham's PEPSM actual structure, materials, and steps of forming the mask to those of the instant claims. Therefore, since Ham's PEPSM (and method of fabricating it) show the same or very similar actual structure and materials as are recited by the instant claims, Ham's PEPSM would have been inherently capable of performing the actual recitations of function and intended use of the instant claims. See MPEP § 2112 and *In re Schreiber*, 128 F.3d 1473, 44 USPQ2d 1429 (Fed. Cir. 1997).

The only argument pursued in this section of the brief by Appellants is what they contend to be a difference in function or intended use for the instantly claimed PEPSM over that of Ham. A recitation directed to the manner in which a claimed apparatus or mask structure is intended to be used does not distinguish the claimed mask structure from that of the prior art (Ham), if the prior art has the capability to so perform. See MPEP § 2114 and *Ex parte Masham*, 2 USPQ2d 1647 (Bd. Pat. App. & Inter. 1987).

As indicated above, the instant claims require that when the PEPSM is used to pattern a photoresist or resist, some kind of pattern is formed in the resist at "*an area* corresponding to an edge of the trench" (of the PEPSM, emphasis added), but is not formed at "areas corresponding to the auxiliary pattern" (of the PEPSM). This intended use as claimed does not specify exactly (a) how wide or how close to the edge of the mask trench the pattern "area" on the resist has to be aligned with the edge of the mask trench, (b) whether the pattern is formed in the resist by light intensity that is either above or below an exposure threshold of the resist as compared to the light intensity that is either below or above the exposure threshold of the resist at the areas corresponding to the auxiliary pattern on the PEPSM, (c) what kind of resist is used (e.g., positive or negative resist, etc.), nor (d) the strength of light intensity required to expose the resist (e.g., the exposure threshold of the resist, etc.). Figure 2 as shown on the front page of the Ham patent is reproduced below for the Board's convenience.



Ham's Figure 2 as shown above illustrates that a higher light intensity is achieved through the PEPSM near the PEPSM trench edge 3A (within "*an area* corresponding to an edge of the trench") than the lower light intensity that is realized under the center areas of the opaque auxiliary pattern portions 5B ("areas corresponding to the auxiliary pattern"). Therefore, it would have been recognized by one or ordinary skill in the art that Ham's PEPSM would be inherently capable of forming a pattern in the resist at "*an area* corresponding to an edge of the trench" (of the PEPSM taught by Ham), while not forming a pattern in the resist at "areas corresponding to the auxiliary pattern" of this prior art PEPSM.

For at least the above reasons, it is still believed that the prior art PEPSM and method of making it taught by Ham would have been inherently capable of meeting the instant claim limitations as they are actually recited.

Apellants argue on pages 10-11 against what they contend to be reliance on common knowledge in this rejection over Ham. However, Ham directly provides sufficient teachings as previously discussed to meet the actual language of the instant claims. Therefore, such common knowledge is neither needed nor relied upon in the prior art rejection over Ham as previously set forth and further addressed above.

B. Claims 6 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of Randall et al. (US Patent Application Publication 2002/0094492).

Response to the arguments under subheading "3)" on pages 11-12 of the brief:

In this section of the brief, Appellants assert that (e) the cited portions of Randall et al. pertaining to Cr regions 34 and 36 in Figures 3a-3b refer to only binary type masks, not PSMs (as recited by *instant claims 6 and 11*). Appellants also contend that (f) Randall et al. do not discuss any auxiliary pattern on a PSM and that (g) no reason had been offered in this rejection for one of ordinary skill in the art to modify Ham's PSM for making the width of the Cr region 5B equivalent to the patterns used on the binary mask of Randall et al.

In regard to (e) above, it is pointed out that the abstract of Randall et al. clearly indicates the express inclusion of Cr regions (34, 36) that are each of critical dimension (CD) width (w_{34}, w_{36}) and that these CD width Cr regions are provided on both the binary (mask) **and the PSM(s)** (35, 33, emphasis added). These Cr region CD widths w_{34} and w_{36} are each specifically exemplified as being 0.2 μ (200 nm) wide (paragraph [0058] lines 4-6), as indicated previously.

In regard to (f) above, even if Randall et al. do not specifically refer to the PSM Cr regions having the CD widths exemplified as "auxiliary" patterns, both these PSM Cr regions

taught by Randall et al. and the PSM Cr auxiliary patterns taught by Ham each have the same effect during exposure since they are each opaque to exposure light.

In regard to (g) above, the reason previously given and repeated above for combining the widths of opaque Cr patterns on the PSM taught by Randall et al. (that are within the instant width range of 30nm-200nm) with the PSM structure having opaque Cr auxiliary patterns of the PEPSM taught by Ham is so that the combined PEPSM would have features that are as small and closely packed as possible to provide a high level of functionality and performance, as taught by Randall et al., for a product (e.g., circuit device, etc.) made by patterned exposure through this PEPSM. Also in Randall et al., the term "photomask" is used broadly, in reference to both 1X masks and reticles for various types of exposures [0004], [0038], as well as in reference to PSMs [0057]. One of ordinary skill in the art would recognize that narrower CD widths of opaque Cr patterns having proven utility on binary masks (e.g., the opaque Cr widths of 160nm or 150nm exemplified by Randall et al., etc., as discussed above) would reasonably be expected to have similar beneficial utility on a PSM and would therefore have been obvious as the opaque Cr auxiliary patterns at the bottom of the PS trenches in the PEPSM structure taught by Ham, for the same reason as indicated above.

C. Claims 16-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of either Kamon (US Patent 6,737,198) or Steinberg et al. (US Patent Application Publication 2002/0031711).

Response to the arguments under subheading "4)"on page 12 of the brief:

In this section of the brief, Appellants repeat their reliance on the previously alleged shortcomings of Ham as argued in a previous section of the brief that corresponds to the previous

art rejection over Ham (which is addressed in section A above). Appellants further contend that neither Kamon nor Steinberg et al. remedies these alleged shortcomings of Ham.

For at least the reasons discussed above, it is believed that the prior art PEPSM and method of making it taught by Ham would have been inherently capable of meeting the limitations of *instant claims 2-5, 7-10, 12, and 14-15* as they are actually recited (which is addressed above in section A).

As set forth above in the applicable ground of rejection, it would have been obvious to one of ordinary skill in the art at the time of the invention for the PEPSM taught by Ham to have employed an additional opaque or optical interference Cr auxiliary pattern formed at the center of the unetched transparent 0° region of width A as taught by either Kamon or Steinberg et al. This would be for the same reason such an opaque or optical interference Cr auxiliary pattern was used at the center of each trench bottom surface (as taught by Ham) so that when this combined PEPSM (taught by Ham and either Kamon or Steinberg et al.) is used to pattern a photoresist layer, it would be inherently capable and fully suitable for forming a photoresist pattern at an area corresponding to an edge of each trench while not forming a photoresist pattern at areas corresponding to the Cr opaque auxiliary pattern or additional Cr opaque auxiliary pattern (which reads on the PEPSM recited by *instant claims 16 and 18-19* and further encompasses the PEPSM recited by *instant claim 17* for an auxiliary pattern of optical interference material that is opaque).

D. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ham (US Patent 5,567,552) in view of either Kamon (US Patent 6,737,198) or Steinberg et al. (US Patent

Application Publication 2002/0031711), and further in view of Randall et al. (US Patent Application Publication 2002/0094492).

Response to the arguments under subheading "5)" on pages 12-13 of the brief:

In this section of the brief, Appellants repeat their reliance on the previously alleged shortcomings of Ham as argued in previous sections of the brief that correspond to the prior art rejections over Ham (which is addressed in section A above), Ham and Randall et al. (which is addressed in section B above), or Ham and either Kamon or Steinberg et al. (which is addressed in section C above). Appellants further contend that neither Kamon, Steinberg et al., nor Randall et al. remedies these alleged shortcomings of Ham.

For at least the reasons discussed above, it is believed that *instant claims 16-19* as they are actually recited would have been obvious over the prior art PEPSM and method of making it taught by Ham and either Kamon or Steinberg et al. (which is addressed above in section C).

As also set forth above in the applicable ground of rejection, it would have been obvious to one of ordinary skill in the art at the time of the invention for the PEPSM taught by Ham and either Kamon or Steinberg et al. to have employed an opaque Cr auxiliary pattern having a well-known line width of 150-200 nm (reading on the instant line width of 30-200 nm), so that the PEPSM would have features that are as small and closely packed as possible to provide a high level of functionality and performance (as taught by Randall et al.) for a product (e.g., circuit device, etc.) made by patterned exposure of a photoresist through this PEPSM for forming a photoresist pattern at an area corresponding to an edge of each trench while not forming a photoresist pattern at areas corresponding to the Cr opaque auxiliary pattern.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

Conclusion

Response to the conclusion section on page 13 of the brief:

In response to Appellants' conclusion statement, it is believed that instant claims 2-12 and 14-20 are still not patentable over the prior art rejections discussed above. Appellants rely on a comparison of unclaimed features illustrated by the instant drawings in comparison with a drawing of the prior art (Ham) and Appellants have failed to recognize the broadest reasonable interpretation of the appealed claims as they are actually recited, which permits the application of the prior art as set forth previously and as further addressed above.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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